PSC-410/411

instruction manual

PSC-410/411

NORTH ATLANTIC
industries, inc.

AC/DC converters

OPERATING AND INSTRUCTION

MANUAL FOR

MODEL PSC-410/411 S 150

PHASE SENSITIVE CONVERTER

Patents are Pending for a Number of Circuits

Used in This Instrument

NORTH ATLANTIC INDUSTRIES, INC.
Plainview New York

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Replacement Parts List

Designation	Description	Source and Part No.
R6, R7	Resistor Fixed, W.W. 10K, 1/8W ±1/4%	NAI #800625
C6, C707	Capacitor, Fixed, 4.7 ufd, 10V Tantalum	NAI #801780

The parts listed on this supplement sheet are for the S450/S495 and are substituted for the parts in the Standard Replacement Parts List.

Supplement #304

SECTION I

SPECIFICATIONS

General: The Phase Sensitive Converter converts A. C. signals to D. C. outputs precisely proportional to either the magnitude of the input voltage, or to the product of the voltage and the sine or cosine of the input phase angle. Ground isolation or differential summing may be accomplished by use of a shielded input transformer.

Output Voltage: 0 to ± 10V, D. C. into a 10K load resistance.

Input Voltage: Full Scale Reading (10V, D. C. Output)

PSC-410: 1.0V to 1,000V in 4 separate decade ranges.

PSC-411: 0.01V to 1,000V in 6 separate decade ranges.

Maximum Input Voltage: (300V RMS Maximum A.C. on 1,000V Scale)

Maximum D. C. - 300V

Maximum D. C. plus peak A. C. - 750V

Function Modes: Total, Fundamental, In-Phase, Quadrature

Frequency Range:

Total	-	350 cps - 10KC (special units, 60 cps to 10KC)
Fund.	-	Frequency of operation, ±5%
In-Phase	-	Frequency of operation, ±5%
Quad.	-	Frequency of operation, ±5%

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Accuracy:	Total	-	0.1% full scale linearity to 1KC, degrading to 1% at 10KC.
	Fund	-	0.1% full scale linearity
	In-Phase	-	0.1% full scale linearity
	Quad.	-	0.1% full scale linearity
	Orthogonality	-	± 0.05°

Temperature Coefficient of Scale Factor: .008%/deg. C from 0° to 50°C

Quadrature Rejection: The maximum null when the signal input leads the reference input by 90° shall be 0 ± 0.01 volts plus an additional 0.5mv tolerance for each cycle of deviation from 400 cps ± 5%. These values shall apply for any signal from zero to full scale.

Conversion Accuracy: ± 0.1% of full scale @ 400 cps ± 5%.

Noise: At zero input signal: D. C. output 10 millivolts maximum.

At full scale signal input: A. C. output 6 millivolts RMS maximum.

Signal Input Impedance: 1 megohm

NOTE: When used with optional shielded transformer for balanced input, the impedance is approximately 300,000 ohms at 400 cps, with a self-resonance at 1,500 cps on the low ranges, 1 megohm on higher ranges (10 volts and above).

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Reference Input Impedance: 100,000 ohms

Load Impedance: 10,000 ohms resistive, adjustable (± 10%) to obtain desired scale factor.

Reference Input: 100 to 130V at frequency of operation ± 5% (special units, at other voltage ratings).

Temperature: 0°C to 55°C (special units, over other temperature ranges).

Frequency Response: The frequency response of the converter shall be as follows for a 400 cps amplitude modulated input signal voltage where the carrier reverses phase at the π and 2π radians points (nodes of the modulated waveform).

Amplitude: The output signal shall be flat within ± 0.1DB for a 400 cps signal modulated from 0 to 50 cps.

Phase Shift: The phase shift between the low frequency modulation waveform and the envelope of the demodulated output waveform shall be within 1.15 deg/cps ± 20% up to 50 cps.

Harmonic Suppression: In the phase sensitive modes, the minimum harmonic rejection ratio shall be as follows:

2nd harmonic - at least 40DB
3rd harmonic - at least 45DB
All higher order harmonics - at least 45DB

Recovery Time: Overload Recovery - Recovery from the removal of a 300V overload to an in-range value of any range shall be accomplished to within ± 0.02 volts of the nominal value on 1.5sec.

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Recovery from an In-Range Step Voltage - The output voltage shall change to within ± 0.01 volts of the nominal value within 100 milliseconds.

Note: The above applies to all units with frequency of operation of 400 cps or greater. For all units at lower frequency of operation, as well as units with extended total range down to 60 cps, the settling time is less than 1.0 seconds.

Overload Protection: Voltages of up to 300V RMS can be applied directly to the input of the converter or any range without damage to the converter. Input impedance specifications are not applicable during over-voltage condition.

Note: Under overload conditions, the output will not fall below 10 volts, nor will it exceed 18 volts.

Non-Synchronous Power Frequency: There is no degradation of performance or accuracy of the converter when the frequency of the power input voltage is not synchronized with the frequency of the signal and reference input voltages.

Programming: Positive or negative 28V D.C. (± 4V) pulses for switching magnetic latching relays to program ranges, function modes, and input modes. (See Section II, "Programming.")

Input Power: 115V, ±5%, 50 to 420 cps - to be fused for 0.1 amp - 6 watts at 60 cps. Plus or minus 28V D.C. (± 4V), 18 watts, 4 milliseconds (minimum) pulse for programming.

Options: Optional isolation transformers available for either signal or reference channels. (For PSC-411, a reference transformer must be used externally where it is not included within the unit.)

Design and Construction:

The A. C. - D. C. Converter has been designed as a miliarized unit using the General Specification Mil-T-21200 as a design guide.

All sub-assemblies will be modularized.

Weight: 14 lbs. approximate.

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SECTION II

GENERAL DESCRIPTION

The Phase Sensitive Converter is a precise instrument capable of phase sensitively connecting A. C. signals to accurate, proportional, D. C. voltages. The phase sensitive D.C. output provided may be used to precisely measure the phase angle of the A. C. input.

The instrument may also be used, with the FUNCTION selection in the "TOTAL" mode, to indicate the total A. C. signal content over a frequency range of 350 cps to 10 KC (60 cps to 10 KC on special units). The fundamental component of the signal may be obtained with the FUNCTION selection in the "FUND" mode. The in-phase component (E cos θ) and the quadrature component (E sine θ) may be obtained from the equipment with FUNCTION in the "IN-PHASE" and "QUAD" modes, respectively. An output voltage of 0 to 10V D.C. will be obtained for any full scale, A. C. input voltage with in the available input ranges. Refer to Section I, "Input Voltage Range."

This basic package has been designed to incorporate shielded reference and/or signal isolation transformers, which provide a means for ground isolation or a means for differential summing. Units equipped with the signal isolation transformer will include the input program shown in Figure 5.5 (Page 5.17). Where the internal reference isolation transformer is not included, an external reference isolation transformer is highly recommended for the PSC 410 to simplify external system wiring and is necessary for the PSC 411.

SECTION III

OPERATING INSTRUCTIONS

(See Figures 5.1 and 5.2)

Before applying power to the converter, be sure that a 10,000 ohms (nominal) resistance is connected across Pins C and D of connector J6. A 10,000 ohms resistor (nominal) should also be connected between Pins G and H of this connector. THE INSTRUMENT WILL NOT FUNCTION PROPERLY IF THIS IS NOT DONE.

The power, 115V, 50 to 420 cps, is applied to Pins A and B of connector J7. The components of the converter will require a short warm-up period before a stable operating condition is reached.

Apply input signal to Pins A and B of connector J6, with Pin B used as low side for "direct" input applications. The A. C. reference input is applied to Pins E and F of connector J6.

NOTE: For either "direct" or "transformer" input, the voltage at Pin E is in-phase with the voltage at Pin A.

Positive phased D. C. output will appear across Pins C and D of connector J6, with C as high side and D as low side. Negative phased D. C. output will appear across Pins G (high) and H (low).

1. Grounding

In order to prevent ground loops, the chassis of this instrument has been isolated from the instrument circuit ground. It is necessary for proper operation that the instrument circuit and chassis ground be at the same potential and hence connected together. This connection may be made either external or internal to the instrument but must be done at only one point.

In instruments without a signal isolation transformer, it is best to connect the low side of the signal (Pin B of J6) to the chassis ground (Pin C of J7). In instruments with signal isolation, this can be done by connecting the output circuit ground (Pin D of J6) to chassis ground (Pin C of J7). In many systems, the case of the instrument is physically connected to a console whose frame is connected to a main

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ground. In this case, it is best to connect the circuit grounds to this main ground and eliminate the use of Pin C of J7. This would result in connection of chassis ground to circuit ground at two points resulting in a ground loop.

In addition, the low side of the power source should be tied to Pin B of J7. This will reduce the effect of stray power ground currents.

2. Programming

Function, Range, and Input

The desired operating condition may be selected by applying a +28V D. C. (±4V) pulse to the appropriate pins of connector J8, for a minimum of 4 milliseconds. This pulse is all that is required by the magnetic, latching-type relays for operation. Note that the programming is a function of the D. C. polarity.

Function Selection

The FUNCTION switching is used to select the desired mode of operation. One of four available modes may be selected.

"TOTAL" The D. C. output signal is proportional to the entire A. C. input signal (RMS).

"FUND" The D. C. output signal is proportional to the RMS magnitude of the fundamental component of the input signal.

"IN PHASE" The D. C. output signal is proportional to that component of the RMS input signal which is in phase with the reference signal.

"QUAD" The D. C. output signal is proportional to that component of the RMS input signal which is in quadrature with the reference signal.

Range Selection

The Range switching is used to select the appropriate sensitivity as defined by that full scale A. C. input corresponding to 10V D. C. full scale output. In effect,

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the proper range scaling attenuators are chosen by this control.

Input Selection (Instruments Equipped with Isolation Transformer Only)

The input selector is used to select either a direct (capacitor) or transformer coupled input. The direct mode is used with a single ended input. The transformer permits use with a floated or differential measurements, the lower impedance input should be connected to Pin A of J6.

3. Operation

Scale Factor Adjust

Adjust 10,000 ohms load resistance across Pins C and D, and the 10,000 ohms resistance across Pins G and H, so that the output voltage measures 10V ± 0.1%, using a measurement technique which will not load these resistances.

Phase Trim

Set RANGE to the most sensitive range position and FUNCTION to the "Quadrature" position. Apply an IN-PHASE signal, equal to most sensitive full scale, to the input terminals. The output should be zero. Because of source impedance effects, frequency of differences, etc., this may not be so. The output may be zeroed by adjusting R2, which is found beneath the "PHASE ADJ" button on top of the instrument.

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SECTION IV

THEORY OF OPERATION

General

The block diagrams and schematics of Figures 5.1 and 5.2 serve to illustrate the principles of operation of the Phase Sensitive Converter.

The PSC-410, which has a 1 volt full scale maximum sensitivity, has the input signal applied through a capacitor to wide band attenuators. The output of these range attenuators is then applied to a very high input impedance amplifier having unity transfer (Z1). For all function modes except "TOTAL" the output of Z1 is fed through a filter L1, and into a stable broadband amplifier, which essentially adds no further phase shift to the signal. In the "TOTAL" position, (see schematic, Figure 5.2) an RC network is inserted between Z1 and Z2 to simulate the transfer of the filter network and yet maintain the "Broadband" capability required in this mode of operation. The output of amplifier Z2 then drives the demodulator circuit (Z5), output filters (L3 and L4) and load, through the signal output transformer (T2). The actual output current is sampled and fed back through a unique, proprietary, arrangement to maintain linearity and phase stability.

In the "TOTAL", as well as the "FUND" mode, the demodulator is arranged as a full wave diode rectifier circuit. In the phase sensitive modes, the diodes are switched out of the circuit and replaced by transistors. The transistors of this demodulator circuit are gated by the reference channel output. The above mentioned feedback is maintained in all modes, thus, minimizing non-linearities and calibration shifts due to any ageing of components that may conceivably exist. The result is a constant D. C. current in the load proportional to the selected component (by function mode control) of the input A. C.

The PSC-411 has a 10 millivolt full scale maximum sensitivity. In the 10mv, 100mv, and 1V scales, the input signal in this unit is applied through a capacitor to amplifier Z1A. In the 10 volts, 100 volt, and 1,000 volt scales, the signal is attenuated by 1,000 to 1 and then applied through a three scale attenuator to Z1B, which is a high gain operational amplifier. The output of Z1B feeds amplifier Z2 through the same filter network combination described above (refer to Figure 5.2).

The 115 volt reference is applied through an isolation transformer, (either external or internal) to prevent ground loops. With the FUNCTION selector in the "QUAD" position, the reference signal is applied to a 90° network. This network maintains the 90° phase shift over the specified band of 5% variation in source frequency. Special units are designed which will accept other input voltages. In any case (see schematic), there is an attenuation of signal level associated with the phase shift network. When in the "IN PHASE" function mode, a resistive attenuator is used to simulate the level change of the 90° network. The result is that in either function mode position the attenuation through the appropriate network used is effectively the same. The output of the network is applied through an isolation amplifier, Z3, to a filter, L2, which is identical to filter L1, in the signal channel. This results in harmonic suppression in both channels, maintaining an identity of transfer.

Although every effort is made to maintain the equality and tracking of the overall phase transfer in both channels under all conditions, wiring differences will undoubtedly occur. In order to permit final phase adjustment of the two channels, the output of filter L2 is applied to a unique, proprietary phasing network, B1. This network permits phase adjustment to be maintained over the 5% frequency range specified. Its output is then applied to the "Reference Square Wave Generator", Z4, resulting in pulses synchronized to the reference input sine wave. These pulses are, in turn, used to trigger the reference output drive, which is contained within, and is part of, the "Reference Driver and Demodulator," Z5.

This "Reference Driver and Demodulator," in effect, performs the ultimate operation of converting the signal channel A. C. to the output D. C. in a phase sensitive manner (see Section IV, Paragraph 2, "Amplifiers," below).

The response of the phase sensitive demodulator is limited to signals at the reference frequency as well as to odd order harmonics. All other frequencies are rejected except for signals very near to the response frequency. Here, the output will oscillate between maximum and zero, as the two near frequencies are alternately in-phase, 90° and 180° out-of-phase. Response for this type detector to odd order harmonics will never be greater (usually less depending upon phase angle), than the fundamental response multiplied by a factor 1/n (where n is the order of the harmonic). Since a signal channel filter is used, there is, of course, essentially no response to harmonics in the inputs.

The effect of reference harmonics is much less important than that of signal harmonic because the harmonic content can never do more than shift the point at which the gates start to conduct. Expressed otherwise, there is an equivalent error in degrees which results from harmonics in the reference channel. Since a reference filter is used, only second harmonics are significant. For measurements using the E cos θ characteristic, the second harmonic effect is small because the output voltage is a function of current integrated over an entire cycle and the small error produced by distortion has a correspondingly small effect on the total current.

2. Amplifiers

All Phase Sensitive Converters contain solid-state circuitry packaged in sealed, potted, humidity-proof, plug-in packages. All designs are based on use of transistors well below maximum manufacturer ratings to insure long life, trouble-free operation. Basically, each amplifier package has a specific function, as described below.

Amplifier Z1 of the PSC-410, and amplifier Z1A of the PSC-411 are identical. This unit is a multitransistor isolation amplifier with extremely high input impedance (between 50 and 100 megohms) and quite low output impedance. Its transfer is effectively unity and exists primarily to permit unloading the input signal source and yet permit proper drive capability of the filter (L1), or range attenuator, as the case may be. The amplifier Z1B, used only on high sensitivity instruments (PSC-411) is a high gain operational amplifier. Range resistors, in conjunction with fixed input and feedback resistors, establish the transfer of this amplifier. Because of the very high effective gain, this amplitude and associated zero phase shift is maintained under all specified conditions. The amplifier is used primarily for the purpose of increasing sensitivity in those units in which it is used.

The amplifier Z2 is a unit designed to operate in conjunction with the demodulator circuit and associated feedback. It has a very high gain bandwidth product, resulting in a phase shiftless power gain, while having a voltage transfer of approximately two.

The isolation amplifier, Z3, is used to unload the input 90° (in "QUAD" function mode) and 0° (in "IN-PHASE" function mode) networks and maintain the fixed required low source impedance.

for proper operation of the reference filter, L2. It differs from the signal isolation amplifier, Z1 (or Z1A), in that the input impedance requirements are not as stringent as that required of the signal channel.

The Reference Square Wave Generator, Z4, is a circuit which accepts a sine wave input and, when loaded by the "Reference Driver and Demodulator" Z5, emits a series of pulses synchronized to the input sine wave. In effect, this generator (Z4) very accurately squares the input sine wave and then differentiates same into pulses of east rise time.

The "Reference Driver and Demodulator," Z5, contains the final reference channel output circuitry, which is a multivibrator type circuit, triggered by pulses from the Square Wave Generator (Z4). The output of this portion is applied to transformer T3, which has six individually floated windings. The primary is driven directly by the multivibrator. One secondary is used as a feedback winding to complete the basic reference drive circuitry. The other four windings are used to switch the gates in the demodulator section of Z5. The feedback loop, described above, preserves the rise time of the fate switching waveform. The demodulator itself consists of four pairs of transistors which are synchronously gated so as to accurately, phase sensitively, convert the signal output to a D. C. form. This D. C. (containing considerable ripple, of course) is then applied to the output through filters L3 and L4, resulting in a "clean" D. C. In detail, the demodulation may be analyzed by considering the gates as switches which connect the output of the signal channel to filters L3 and L4 (in series with the D. C. load) on alternate half cycles. The complex cross feedback loops contained in the reference and signal channels result in a D. C. output current which is held constant under all specified conditions. Therefore, the exact output scaling, from a voltage standpoint, is strictly dependent upon the stability of the load resistance.

In the "TOTAL" and "FUND" positions of the FUNCTION mode selector, the four pairs of gated transistors are replaced by four ungated diodes and the reference channel output is removed. The result is a D. C. operation similar to that described above, with the exception that there is no synchronous gating of the switches.

3. Filters

Filters L1 and L2 are low pass filters designed to cut off at the second harmonic of the operating frequency. Their use in the signal and reference channels permit sufficient rejection of harmonics and noise consistent with the overall instrument specifications.

Filters L3 and L4 are exceedingly flat, low pass, filters with a cutoff at 300 cps. (Special units which go down to 60 cps contain a filter with a 45 cps cutoff.) These filters are designed to result in optimum between maximum filtering of ripple and minimum settling time.

4. Power Supply

The power supply is a transistorized unit using a conventional full wave diode bridge rectifier. The output of the rectifier is filtered and then fed to two Zener diode controlled regulators which independently supply the reference and signal channels.

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SECTION V

MAINTENANCE

The following section contains instructions for the maintenance and alignment of the Phase Sensitive Converter. It is recommended that these procedures be followed only if proper test equipment is on hand and if sufficiently skilled personnel are available to perform the work.

Cover Removal

To remove cover, remove twelve screws from top and bottom of U shaped cover. It is recommended that a dummy cover with holes cut for access to adjustments be used, in place of normal cover, for precise results.

Component Replacement

Amplifiers

Remove 2 screws from underside of chassis at each amplifier to be removed, except Z4 which has 4 screws. Upon replacement, part numbers must be checked to guarantee proper location. Replace screws on underside of chassis.

Relays

All relays, with the exception of K801, are plug-in relays. To replace these relays, it is necessary to remove the screws which hold the terminal board to the chassis. The relay may then be removed by prying it from its socket. The replacement relay should have sufficient paint removed to insure grounding of its case to the socket. Replace terminal board chassis.

Transistors

There are transistors on TB6 (power supply) which may be replaced with the same type. A heat sink should be used to prevent damage to the transistor.

NOTE: Other maintenance adjustments have been described in Section III.

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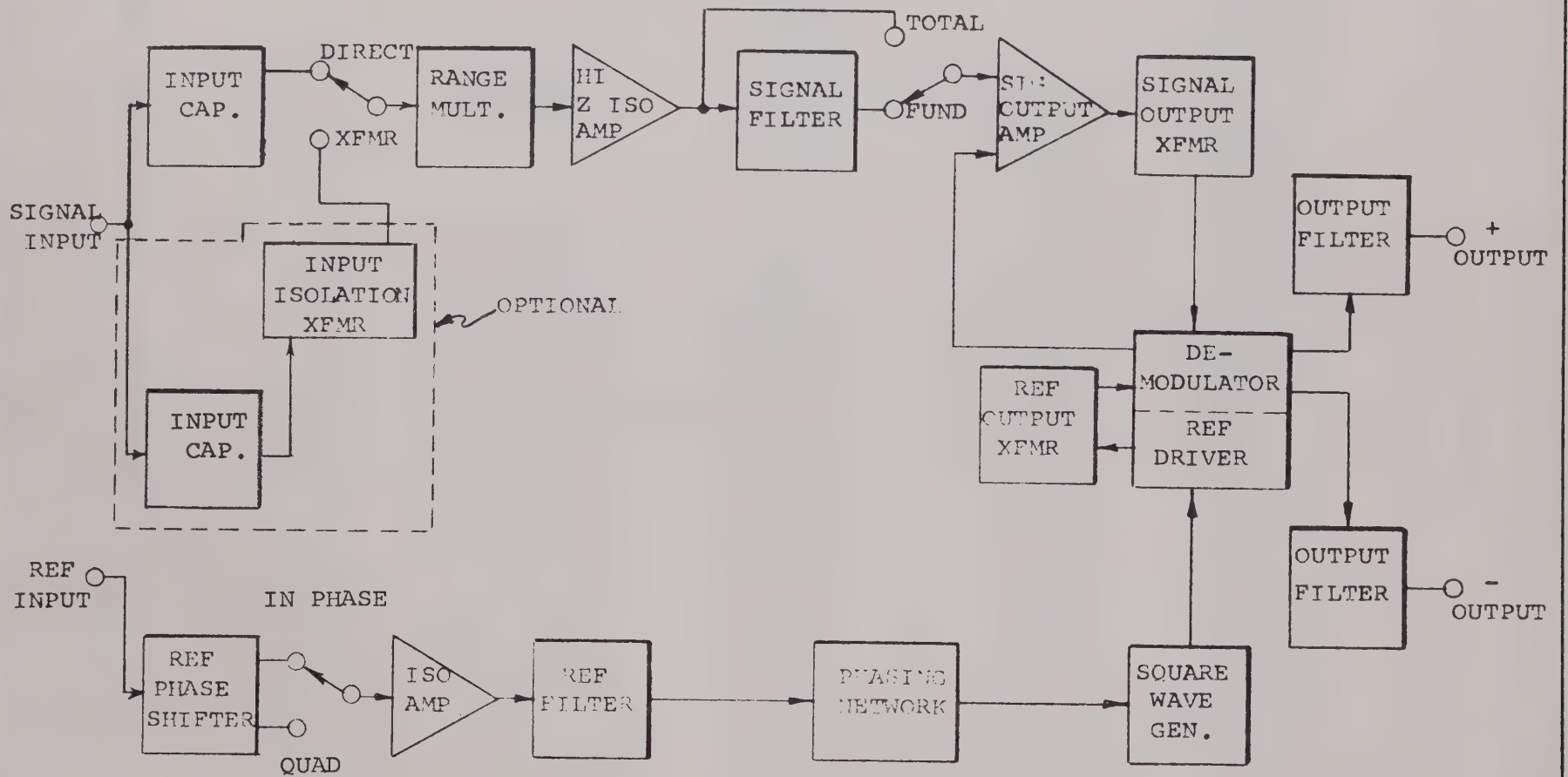
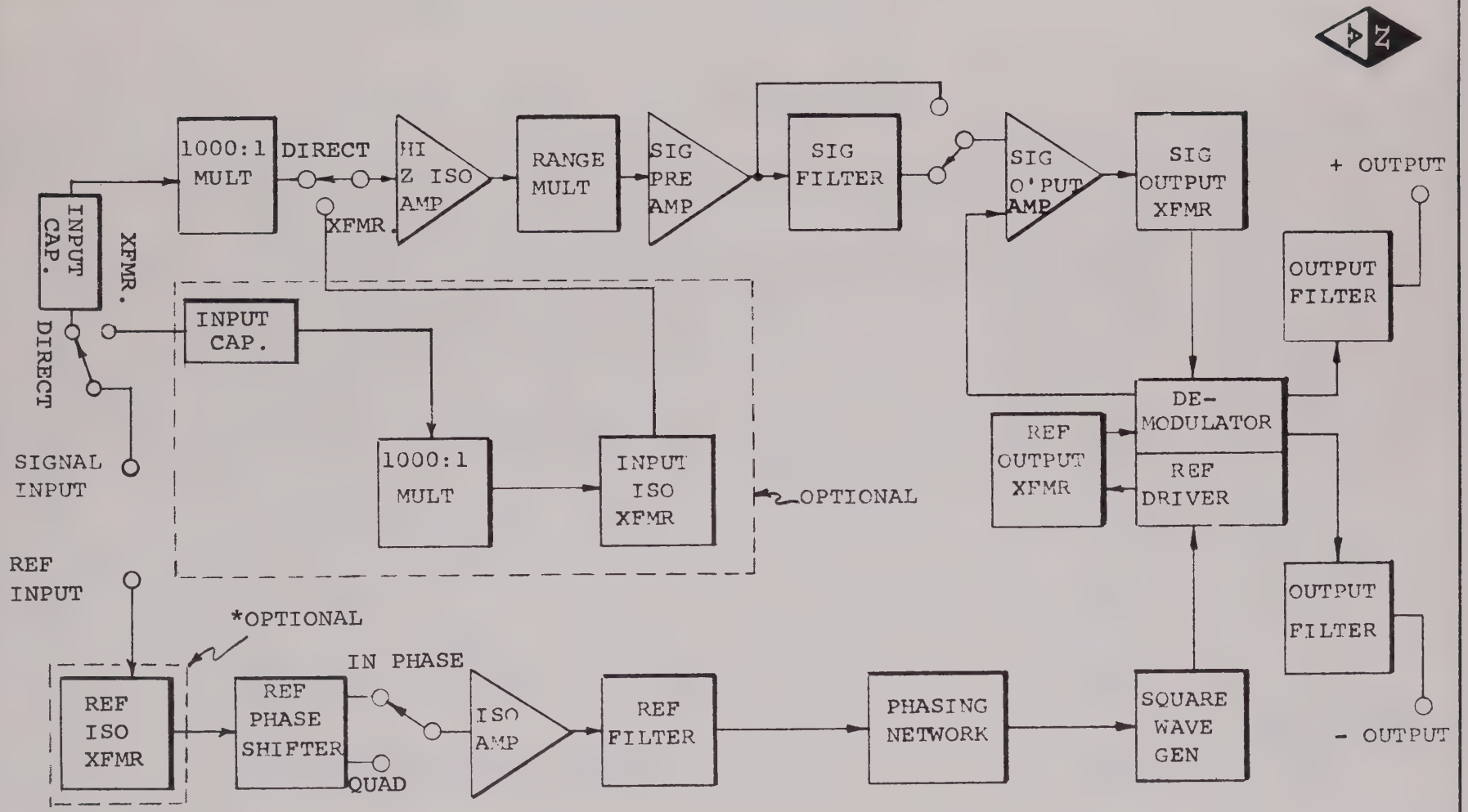


BLOCK DIAGRAM

PSC-410

FIGURE 5.1A



* Must be used with PSC-411 either built in or externally.

BLOCK DIAGRAM

PSC-411

FIGURE 5.16

REPLACEMENT PARTS LIST

Designation	Description	NAI Part No.	Manufacturer
C1,C2	Capacitor, 0.5uf, 600V, ± 20%	801183	Hopkins Type P56D
**C3	Capacitor, Tantalum, 2.2ufd, 20V, ± 10%	800596	Sprague 150D225X9020A2
R1	Resistor, Metal Film, 1 Meg., 1/2W, ± 1%	801161	
**R5	Resistor, Metal Film, 10K, 1/2W, ± 1%	801102	
R9,R10	Resistor, Fixed, WW, 18K, 5W, ± 3%	801362	Dale RS-5
R11	Resistor, Fixed, WW, 25 ohms, 3W, ± 5%	800075	Dale RS-2
R15	Resistor, Fixed, Metal Film, 175K (nominal) 1/2W,±1%	801640	
Z1 or Z1A	Amplifier Assembly, High Impedance Isolation	782049	
Z1B	Amplifier Assembly, Signal Preamplfiier	782067	
Z2	Amplifier Assembly, Signal Output Amplifier	782042	
Z3	Amplifier Assembly, Isolation Amplifier	782060	
##Z4	Amplifier Assembly, Reference Square Wave Generator	782043-2	

** C107 when TB1 is used. R101 when TB1 isused.

Frequency dependent component, above listing is for 400 cps. For other frequencies, seee Page

Designation	Description	NAI Part No.	Manufacturer
Z5	Amplifier Assembly, Reference Driver and Demod.	782054	
##B1	Phasing Network	782065-2	
TC1	Temperature Compensator	500206	
J1 - J4	Connector, 15 Pin Female	801799	Cannon DASM15-S
J5	Connector, 27 Pin Female	801801	Cannon DCSM37S
J6	Connector	801208	Bendix SP02-12-8P
J7	Connector	801209	Bendix SP02-8-3P
J8	Connector	801210	Bendix SP02-14-19S
T1,T5	Transformer, Input (Optional)	B117-2.000-30	
T2	Transformer, Signal Output	200615	
T3	Transformer, Reference Output	200994	

Frequency dependent component, above listing is for 400 cps.
For other frequencies, see Page

REPLACEMENT PARTS LIST (Continued)

Designation	Description	NAI Part No.	Manufacturer
T4	Transformer, Power	500205	
##L1,L2	Filter	500204-6	
L3,L4	Filter (For special 60 cps instruments)	801030 801429	
TB1~			
C101,102, 103,104	Capacitor, Mica, Variable, 100uufd, 500uufd	801194	Arco #304
C107	Capacitor, Tantalum, 2.2ufd, 20V, ±10%	800596	Sprague 150D225X9020A2
R101	Resistor, 10K, 1/2W, ±1%, Metal Film	801102	
K101,K102 103, 104	Relay, Plug-In, 28V, D. C.	801196	
TB5 Assembly			
C501	Capacitor, Tantalum, 2.2ufd, 20V, ±10%	800596	Sprague 150D225X9020A2
C502,C503	Selected at test		
R501,R502	PSC-411 Resistor, Metal Film, 17K, 1/2W, ±1%	801631	

Frequency dependent component, above listing is for 400 cps. For other frequencies, see Page

~ Used with optional input transformer only.

Designation	Description	NAI Part No.	Manufacturer
R501	PSC-410 Resistor, Metal Film, 28K, 1/2W, ±1%	801792	
R502	PSC-410 Resistor, Metal Film, 10K, 1/2W, ±1%	801102	
R503	Resistor, Variable, 1K, (Trimpot)	801175	Bourns Model 3010-L-102
R504	Selected at Test		
R505	PSC-410 Resistor, Metal Film, 10K, 1/2W, ±1%	801102	
R506	PSC-410 Resistor, Metal Film, 25K, 1/2W, ±1%	801793	
K501,502,503	Relay, Plug-In, 28V D. C., Latching	801196	
TB6 (Power Supply Assembly			
C601,C602 C603,C604, C605	Capacitor, Tantalum, 40ufd, 75V	801196	
R601	Resistor, WW, 250 ohms, 7W, ±5%	802199	Sprague 244E
R602,R603	Resistor, Comp., 2.2K, 1/2W, ±5%	800079	
CR601,CR602 CR603,CR604	Diode, Silicon, IN64	800323	

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Designation	Description	NAI Part No.	Manufacturer
CR605,CR606	Diode, Zener, 30V, 1W, ±5%	801203	
Q601,Q602	Transistor, Germanium	801204	T.I. 2N1038
TB7 Assembly			
C701,C705	Capacitor, Ceramic, 3-12uufd, Variable	800102	Erie Type TS-B
C703	Capacitor, Ceramic, Variable, 7-45uufd	800040	Erie Type TS-B
C702	PSC-410 Capacitor, Fixed, Mica, 68uufd, 500V, ±5%	801188	Elmenco DM15-E680J
	PSC-411 Capacitor, Fixed, Mylar, .0068ufd, 100V, ±5%	801181	Goodall-633UW
C704	PSC-410 Capacitor, Fixed, Mica, 680uufd, 300V, ±5%	801189	Elmenco DM15-F-681J
	PSC-411 Capacitor, Fixed, Mica, 100uufd, 500V, ±5%	801264	Elmenco DM15-F-101F
C706,	PSC-410 Capacitor, Mylar, .0068ufd, 100V, ±5%	801181	Goodall-633UW
	PSC-411 Capacitor, Mica, 1000ufd, 100V, ±5%	801240	Elmenco DM15-F-102K

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REPLACEMENT PARTS LIST (CONTINUED)

Designation	Description	NAI Part No.	Manuafacturer
R703	PSC-410 Resistor, Metal Film, 900K, 1/2W, ±1%	801152	
	PSC-411 Resistor, Metal Film, 999K, 1/2W, ±1%	801156	
R704	PSC-410 Resistor, Metal Film, 108K, 1/2W, ±1%	801153	
	PSC-411 Resistor, Metal Film, 990 Ohms, 1/2W, ±1%	801157	
R706	PSC-410 Resistor, Metal Film, 990K, 1/2W, ±1%	801154	
	PSC-411 Resistor, Metal Film, 50K, 1/2W, ±1%	801360	
R707	PSC-410 Resistor, Metal Film, 10K, 1/2W, ±1%	801102	
	PSC-411 Resistor, Metal Film, 12K, 1/2W, ±1%	801158	
R709	PSC-410 Resistor, Metal Film, 999K, 1/2W, ±1%	801156	
	PSC-411 Resistor, Metal Film, 500K, 1/2W, ±1%	801358	
R710	PSC-410 Resistor, Metal Film, 990 Ohms, 1/2W, ±1%	801157	
	PSC-411 Resistor, Metal Film, 9.5K, 1/2W, ±1%	801359	
~R702,R705	PSC-410 Resistor, Variable, 5K (Trimpot)	801172	Bourns Model 3010-L-502

~ R702 used only with optional input transformer.

Designation	Description	NAI Part No.	Manufacturer
R705	PSC-411 Resistor, Variable, 20 Ohms (Trimpot)	801174	Bourns Model 3010-L-200
R702	PSC-411 Resistor, Variable, 5K (Trimpot)	801775	Bourns Model 3010-L-502
R708	PSC-410 Resistor, Variable, 200 Ohms (Trimpot	801173	Bourns Model 3010-L-201
	PSC-411 Resistor, Variable, 1K (Trimpot)	801175	Bourns Model 3010-L-102
R711	PSC-410 Resistor, Variable. 20 ohms, (Trimpot)	801174	Bourns Model 3010-L-200
	PSC-411 Resistor, Variable, 1K (Trimpot)	801175	Bourns Model 3010-L-102
K701,K702 K703,K704	Relay, Plug in, 28V D. C. Latching	801196	
TB8*			
C801	Capacitor, Ceramic, Variable, 7-45uufd	800040	Erie Type TS-E
C802	Capacitor, Mica, Selected at Test		ElmencoDM15

* Frequency and reference voltage dependent components. Above listing for 400 cps and 115 volt reference. For other references, voltages, and frequencies, see Page

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Designation	Description	NAI Part No.	Manufacturer
C803	Capacitor, Mica, 200uufd, 500V, ±1%	801735	Elmenco DM15-F-201F
R801,R803	Resistor, Metal Film, 100K, 1/2W, .5%	801148	
R807	Resistor, Metal Film, 20K, 1/2W, .5%, T1 T.C.	801149	
R802,R804	Resistor, Dep. Carbon, 100K, 1/2W, .5%	801150	
R805	Resistor, Dep. Carbon, 2 meg., 1/2W, .5%	801147	
R806	Resistor, Dep. Carbon, 20K, 1/2W, .5%	801151	
K801	Relay, 28V D. C. Latching	801195	
TB19~	Used in PSC-411 with optional s ignal input transformer only.		
C1901	Capacitor, Ceramic, Variable, 3-12uufd	800102	Erie Type TS-B
C1902	Capacitor, Fixed, Mylar, .0068ufd, 100V, ±5%	801181	Goodall-633UW
C1903	Capacitor, Fixed, .22ufd, 400V	802674	Hopkins Type P2240
R1901	Resistor, Fixed, Metal Film, 999K, 1/2W, 1%	801156	

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Designation	Description	NAI Part No.	Manufacturer
R1902	Resistor, Fixed, Metal Film, 990 Ohms, 1/2W, ±1%	801157	
R1903	Resistor, Variable, 20 Ohms, (Trimpot)	801174	Bourns Model 3010-L-200
K1901,K1902	Relay 28V D. C. Latching	801196	

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FREQUENCY DEPENDENT ASSEMBLIES

Frequency	Assembly #	Assembly #	Assembly #
60~	-1	-1	-12
120~	-4	-4	-14
400~	-2	-2	-6
800~	-3	-3	-24
1 KC	-5	-5	-7

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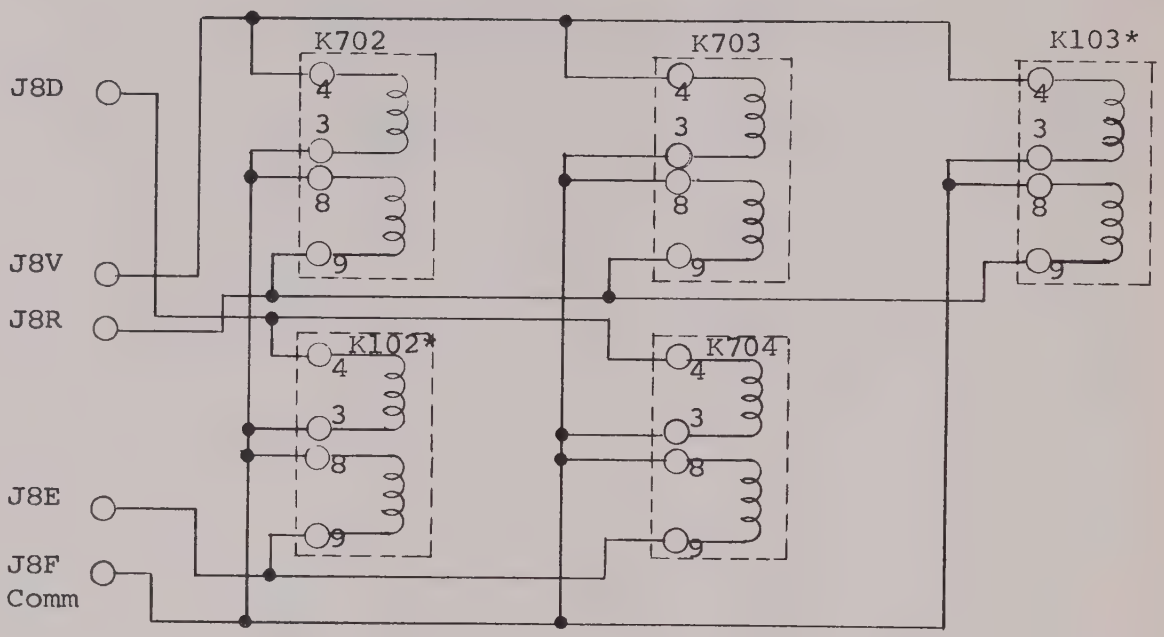
RANGE PROGRAMMING CIRCUIT

FOR

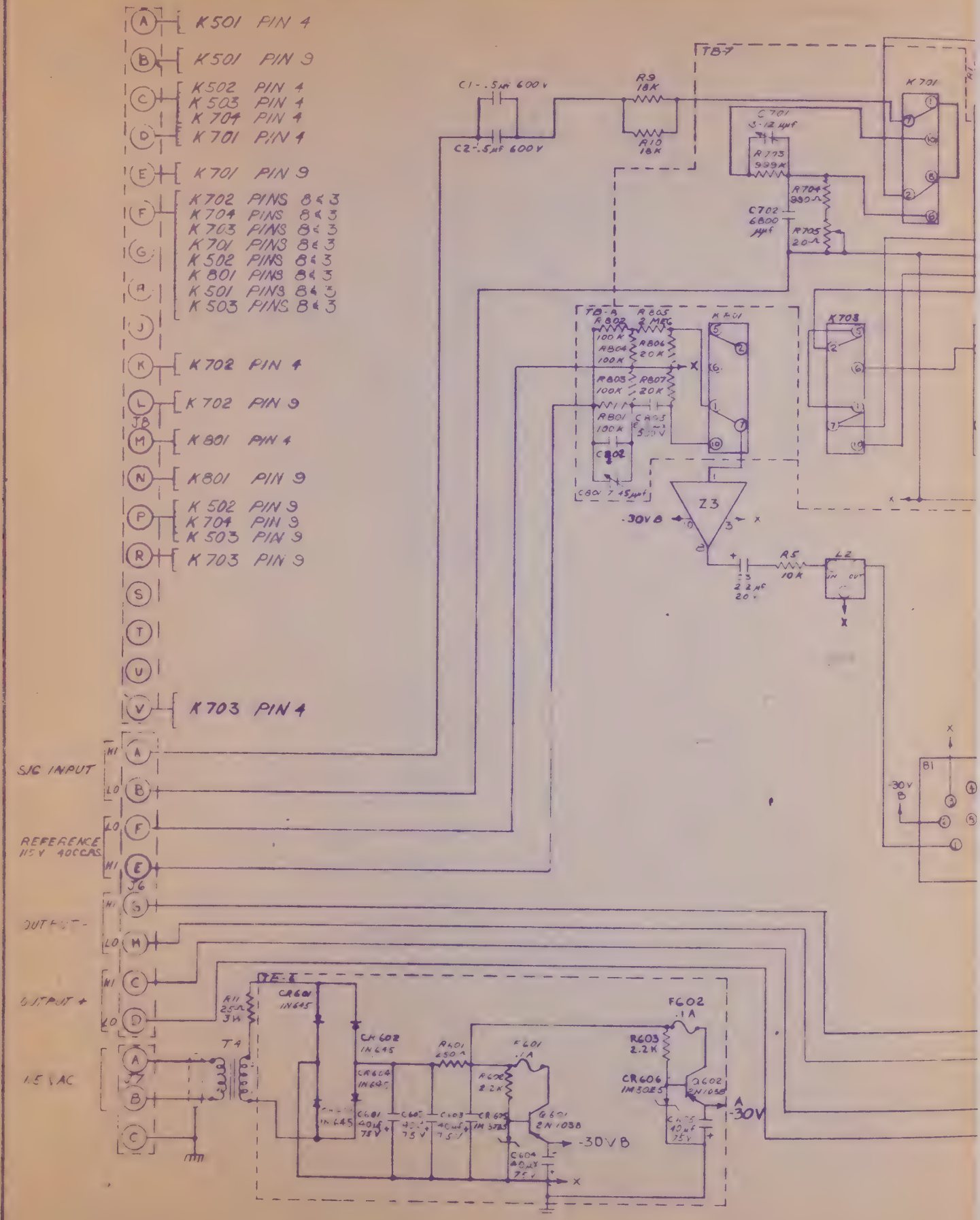
PSC-410



Program	+28V Program Energize	-28V Program Energize	Power @ 28V
1 volt full scale	V and D	R and E	1.5 Watts
10 volts full scale	R and D	V and E	Per Relay
100 volts full scale	V and E	R and D	
1,000 volts full scale	R and E	V and D	

* K-100 series relays (TB-1) and K-1901 (TB-19) apply to units with input transformer only. All other instruments do not contain TB-1 or TB-19 and their associated components.

Figure 5.3


A K501 PIN 4
B K501 PIN 9
C K502 PIN 4 K503 PIN 4 K704 PIN 4
D K701 PIN 4
E K701 PIN 9
F K702 PINS 8 & 3 K704 PINS 8 & 3 K703 PINS 8 & 3 K701 PINS 8 & 3 K502 PINS 8 & 3 K801 PINS 8 & 3 K501 PINS 8 & 3 K503 PINS 8 & 3
K K702 PIN 4
L K702 PIN 9
M K801 PIN 4
N K801 PIN 9
P K502 PIN 9 K704 PIN 9 K503 PIN 9
R K703 PIN 9
V K703 PIN 4
J8
J6
J7
S/C INPUT
REFERENCE 115 V 400 CAS
OUTPUT -
OUTPUT +
115 VAC
HI
LO
TB-7
TB-8
C1 - .5 MF 600 V
C2 - .5 MF 600 V
R9 18K
R10 18K
C701 5-12 MMF
R703 999K
R704 990Ω
C702 6800 MMF
R705 20Ω
K701
K703
K801
R802 2 MEG
R804 100K
R805 100K
R806 20K
R807 20K
R801 100K
C803 .5 MF 50V
C802
C804 7-45 MMF
Z3
-30V B
R5 10K
L2
C5 2.2 MF 20V
B1
T4
R11 25Ω 3W
CR601 IN645
CR602 IN645
CR604 IN645
CR605 IN645
C601 40 MF 75V
C602 40 MF 75V
C603 40 MF 75V
R601 450Ω
R602 2.2K
Q601 2N1038
C604 40 MF 75V
FG602 .1A
R603 2.2K
CR606 IN5085
Q602 2N1038
C605 10 MF 75V
-30V
X

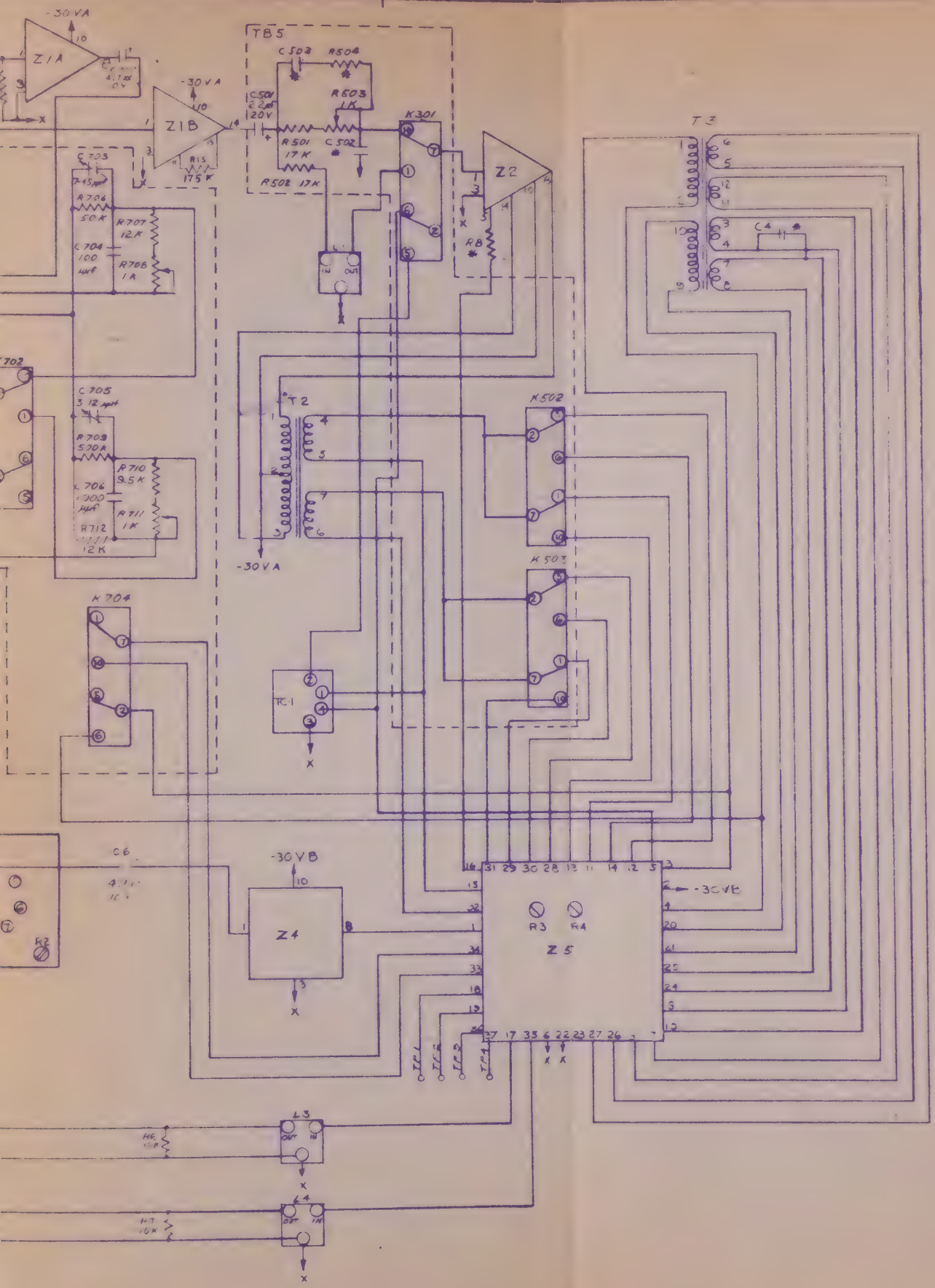
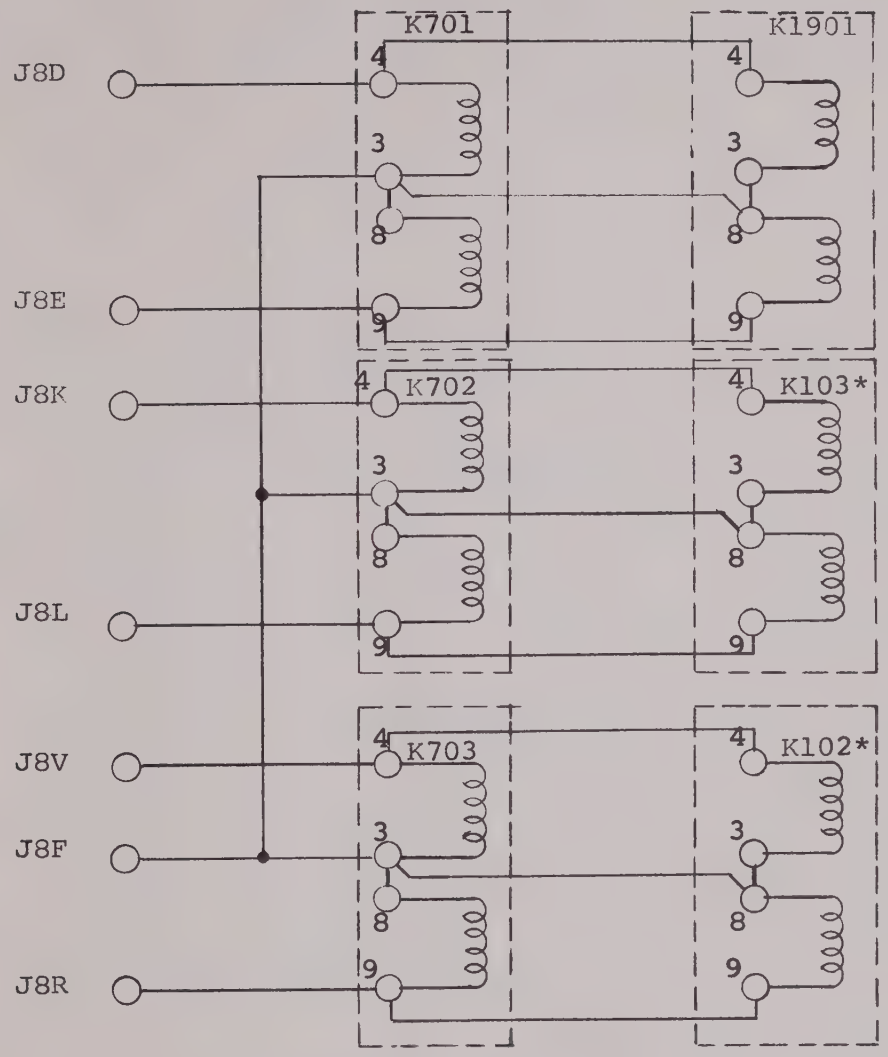


FIG. 5.2

* VALUE TO BE DETERMINE. AT TEST

RANGE PROGRAMMING PSC-411
(6 Ranges)

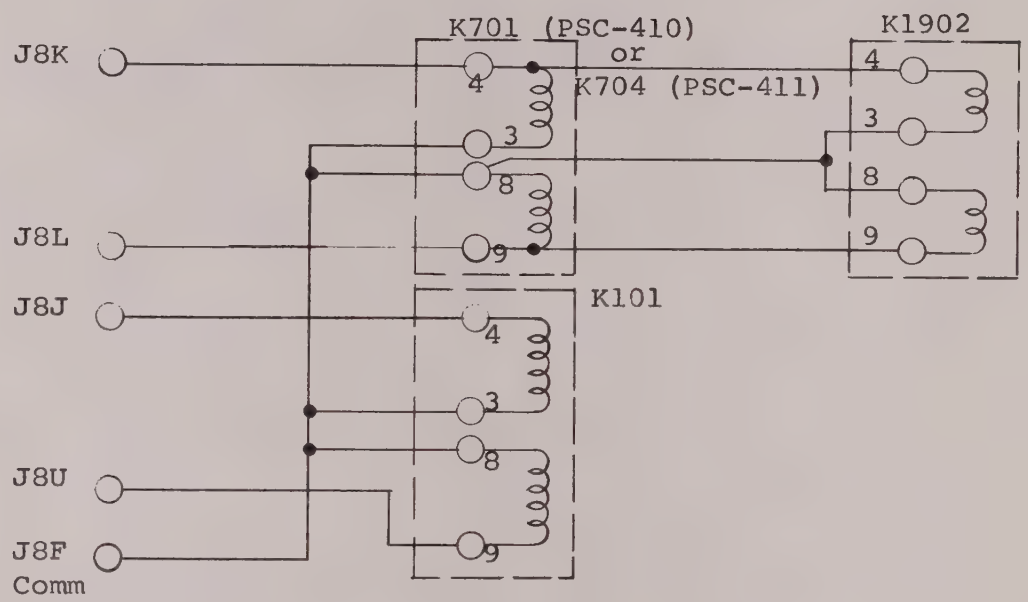


	+28V Program Energize	-28V Program Energize	Power @ 28V
10MV	DKV	ELR	1.5 watts per
100MV	DLR	EKV	relay
1V	DKR	ELV	
10V	EKV	DLR	
100V	ELR	DKV	
1000V	EKR	DLV	

* K-100 Series Relays (TB-1) and K-1901 (TB-19) apply to units with input transformer only. All other instruments do not contain TB-1 or TB-19 and their associated components.

Figure 5.4

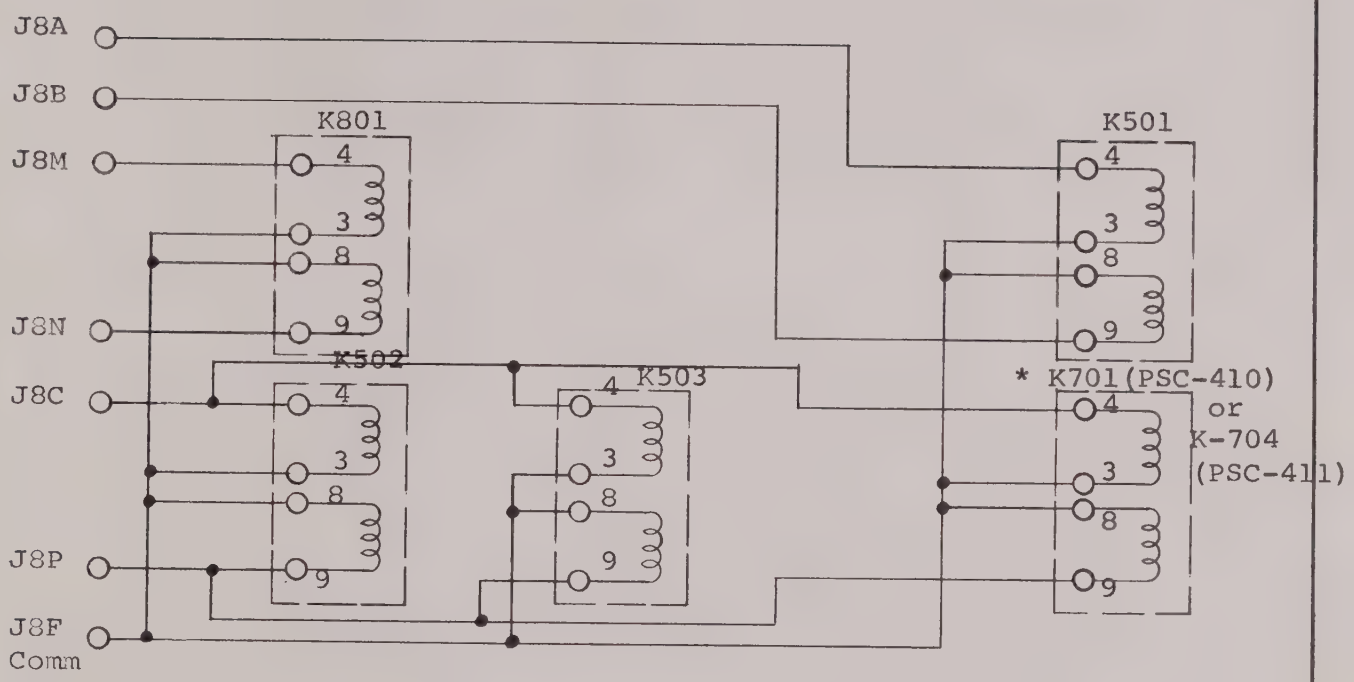
SIGNAL INPUT PROGRAMMING
for
PSC-410 & PSC-411
(FOR UNITS WITH OPTIONAL INPUT TRANSFORMER)



Program	+ Program Energize	-Program Energize	Power @ 28V
Direct (single ended)	K and J	L and U	1.5 watts per relay
Floated	L and U	K and J	

For P,S.C. 411 - all relays are wired in parallel and are programmed by applying 28V signals to Pins J and U.

FUNCTION PROGRAMMMING CIRCUIT
for
PSC-410 and 411



Program	+ Program Energize	- Program Energize	Power @ 28V
Total	B & P	A and C	1.5 watts per relay
Fund	A & P	B and C	
In Phase	A-M-C	B-N-P	
Quadrature	A-N-C	B-M-P	

* Becomes K104 in units with optional input transformer.

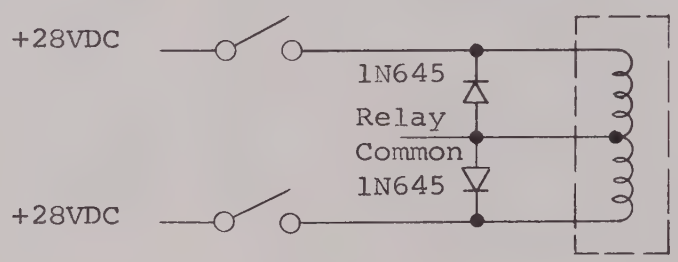
Fig. 5.6

RELAY SUPPRESSION

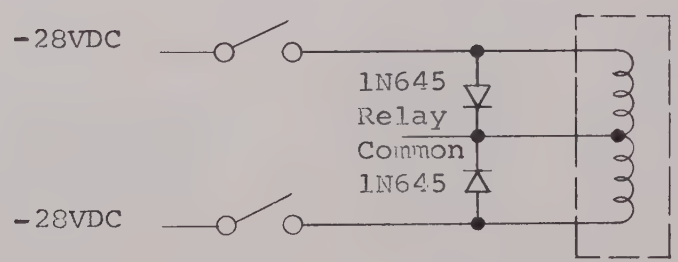
It is strongly recommended that for optimum performance, external relay suppression be supplied.

A suggested method of achieving this would be to connect a 1N645 Diode from every relay switching point to relay common with appropriate polarity as shown below:

POSITIVE PROGRAMMING



NEGATIVE PROGRAMMING



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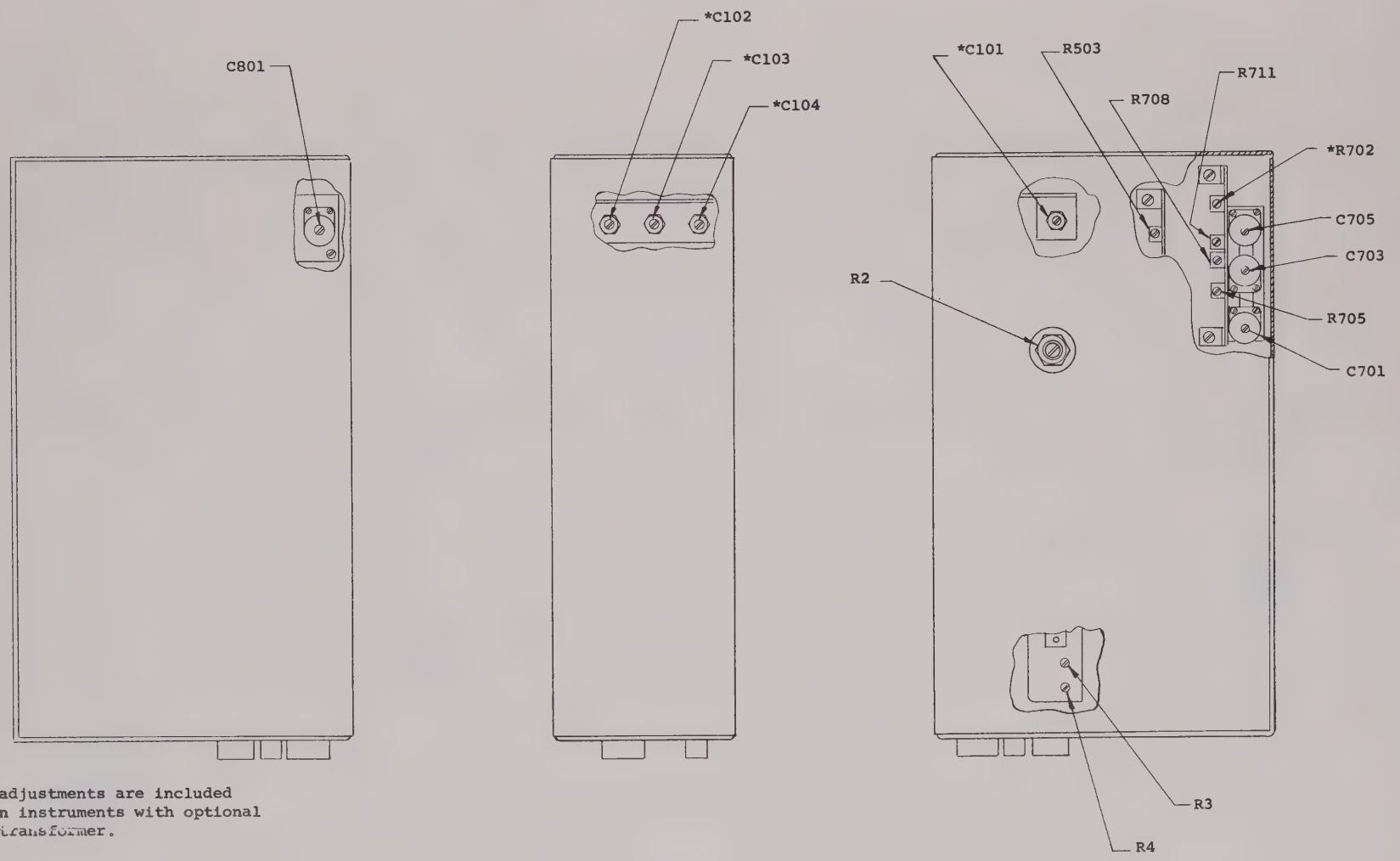
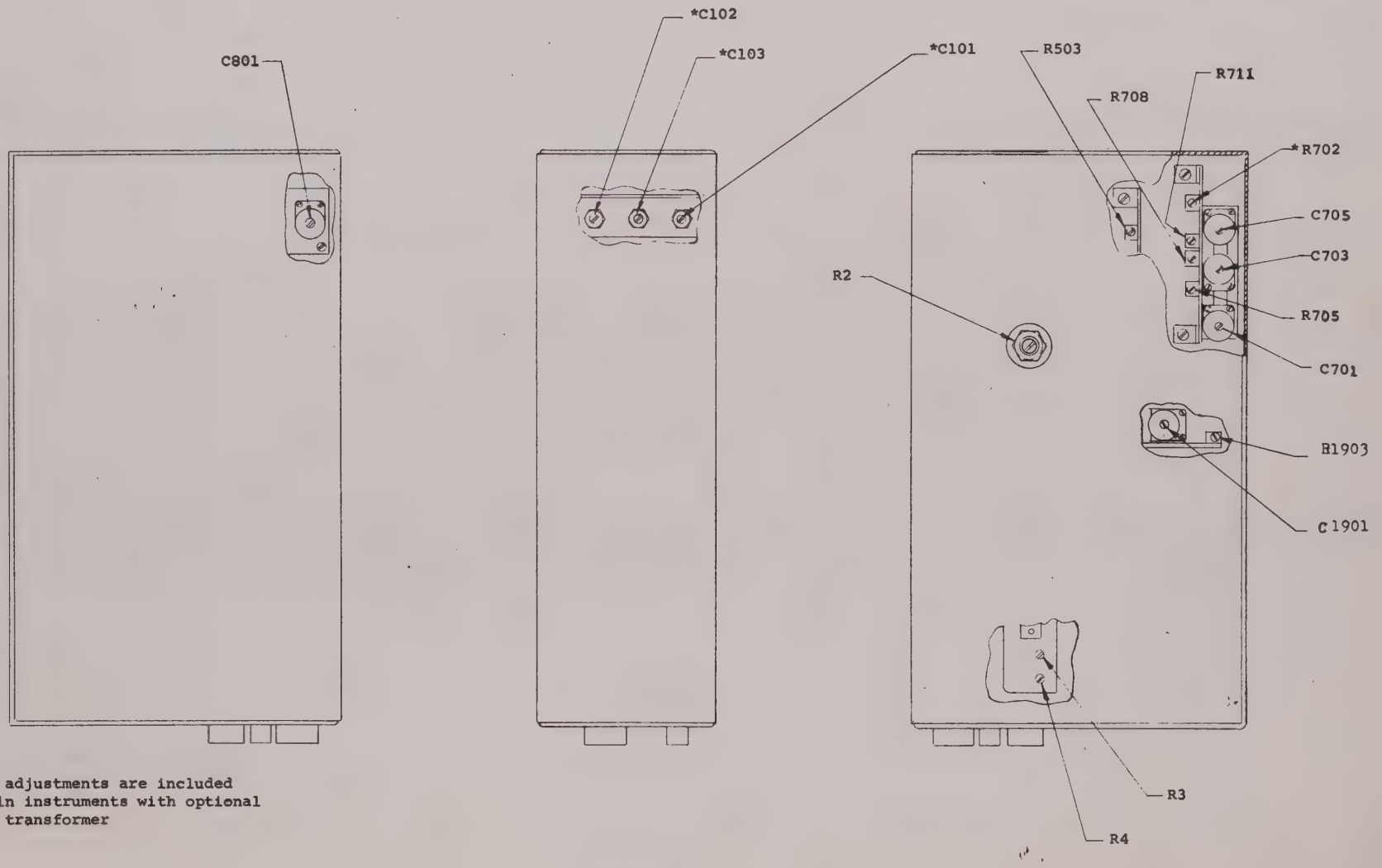


* These adjustments are included only in instruments with optional input transformer.

PSC-410

CALIBRATION ADJUSTMENT LOCATIONS
Fig. 5.8



* These adjustments are included only in instruments with optional input transformer

PSC-411

CALIBRATION ADJUSTMENT LOCATIONS

Figure 5.9

SECTION VI

CALIBRATION AND TEST PROCEDURE

Equipment Required

1. 115V signal source capable of generating frequency of operation for unit under test:

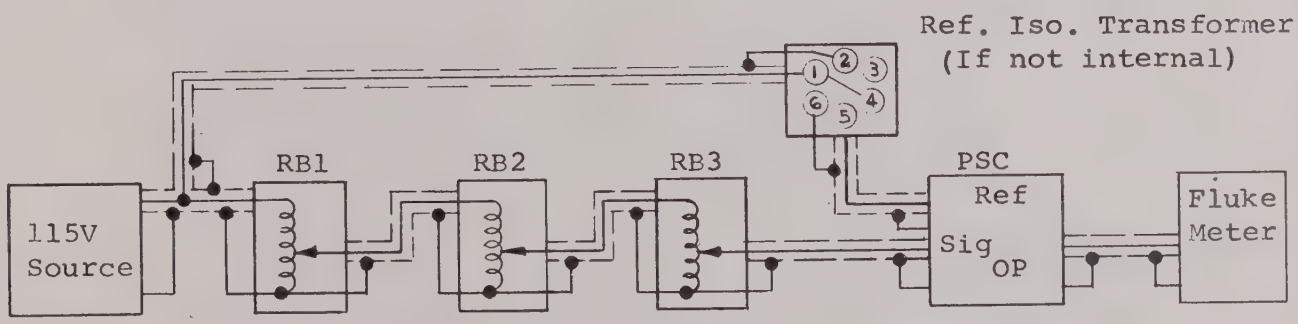
   Accuracy: Frequency ±1/2%
   Stability ±.01%
   Elin Model RK-115-17)

2. Differential VM (A.C. & D.C.)

   Accuracy: A.C. ±0.2% (Calibrated at 100V by Holt or equal to .025%).
   D.C. ±0.05% (Fluke Model 803)

3. Three North Atlantic Industries, RB-504 Ratio Transformers or equal for PSC-411 or two for PSC-410.

Connect instrumentation as shown:



I. Preliminary Operational Check

The following checks are for the purpose of spotting faulty instruments before proceeding with the calibration procedure. (NOTE: All outputs should be read at the plus terminal, except where noted.)

A) Turn on instrument and check both -30V output points at power supply (indicated on schematic). Should be -30V ± 1.5V.

B) With input shorted, output should be 0 in all ranges and functions. (Less than 10mv).

C) Set FUNCTION to "FUND," input mode to "DIRECT," and using the most sensitive range for the instrument in use, apply the input signal equal to full scale sensitivity of that range, at the frequency of operation. Read output with Fluke meter. Adjust R3 (a screw driver adjustment under the top cover). Output should vary through a full scale output of 10V. Observe waveform at feedback point (T2, Pins 5) with scope. It should remain sinusoidal for a D. C. output up to 11 or 12 volts.

D) Set FUNCTION to "TOTAL," and repeating procedure of Step C, adjust R503, found on TB5 under top cover of instrument.

E) With "FUNCTION" set to "IN PHASE" and adjusting R4 located adjacent to R3 under top cover, repeat procedure of Step C.

Note: Proper operation of this most sensitive range will insure correct operation in the other less sensitive ranges.

II. Calibration Procedures

A) Frequency Response Trim (Direct and Total Mode)

1. In the most sensitive range position, apply a 90% of full scale voltage to the input. Sweep the frequency of the input from 350 cps to 10KC and note the variation of the output with respect to 90% of full scale output (9V D.C.). Adjust C502, C503, and R504 so that the maximum deviation does not exceed ± 1%. (The input should be monitored with a meter which has a frequency response which is flat to ± 0.1% over this frequency range.)

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2. Repeat Step 1 for all available ranges after completion of the Range Calibration and Range Quadrature Trim (Section D and E).

B) Voltage Sensitive Calibration

NOTE: Use only .1 and .01 scales on ratio boxes to insure maximum accuracy. RB #3 is not necessary for PSC-410.

1. "Fund" position. Most Sensitive range (As in 1C)

Set Ratio Box #1 to provide exactly 100V as measured by the Fluke meter. Set Ratio Box #2 to the .01 position (1V for PSC-410) and Ratio Box #3 to the .01 position (10mv for PSC-411) adjust R3 to produce a 10V D. C. (±2.0mv) output from the converter.

2. "Total" position. Most Sensitive range (As in 1D)

Check 100V A.C. input signal with Fluke meter. Adjust R503 to produce a 10V D.C. output.

3. "Transformer" input (Where applicable)

Switch input to "transformer" position. (In the case where there are both Reference and Signal Isolation transformers, internal circuit ground must be tied to chassis ground. This may be accomplished at the output terminals.) Repeat Steps 1 and 2, adjusting R702 on TB7. (See Figure 5.7 or 5.8)

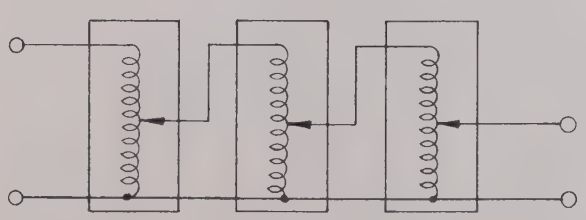
4. Check linearity in 1, 2, and 3 by switching RB3 down scale and reading corresponding voltages on Fluke. Linearity should be within 10mv.

C) Phase Sensitive Calibration

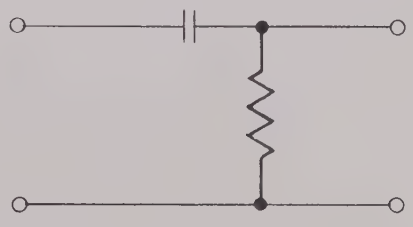
1. In-phase and quad. signal inputs are derived in the following manner:

FOR PSC 411

IN-PHASE



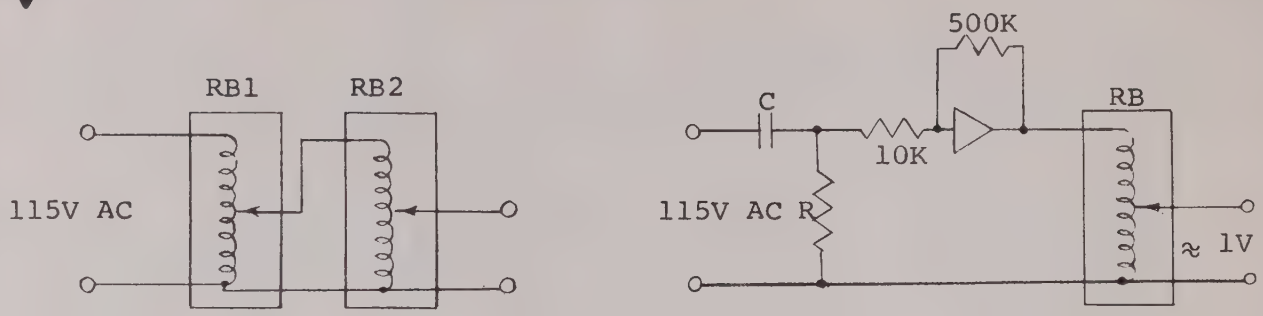
QUAD



Other frequencies	400 cycles	800 cycles
X_C approx. 2,000 times R	C = .001	.001
R less than 200 ohms	R 180 ohms	90 ohms

NOTE: C should be a low-loss capacitor such as mica, polystyrene, etc.

FOR PSC-410



2. Orthoganality Trim

Switch converter to "IN PHASE," mode to "DIRECT" and most sensitive range. Apply a full scale quadrature signal to input by adjusting RB to approximately 1V for PSC-410, or R to provide approximately 10mv for PSC-411. Adjust R2, phase trim adjustment, for 0 D. C. output. Remove quadrature signal, and with switch in "QUAD" position, apply a full scale, in-phase signal to input. Adjust capacitor C801 on TB8 for 0 D. C. output.

Set FUNCTION switch to "IN-PHASE." Check linearity with an in-phase input equal to full scale value of most sensitive range (as in B, Step 4). Repeat procedure for quadrature signal (should be within 10mv, D. C. output).

D. Range Calibration ("DIRECT" mode) All adjustment made to ± 2.0mv.

PSC-410

1. In "FUND," 10V range, apply 10V A. C. to input and adjust R705 on TB-7 for 10V D. C. output. In "QUAD" adjust C701 on TB-7 for zero output. Check "FUND."

2. In "FUND," 100V range, apply 100V A. C. to input and adjust R708 on TB-7 for 10V D. C. output. In "QUAD" adjust C703 on TB-7 for zero output. Check "FUND."

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3. In "FUND," 1,000V range, apply 300V A. C. to input and adjust R711 on TB-7 for 3V D. C. output. In "QUAD" adjust C705 on TB-7 for zero output. Recheck "FUND."

PSC-411

1. In "FUND," 100mv range, apply 100mv A. C. to input and adjust R708 on TB-7 for 10V D. C. output. In "QUAD" adjust C703 on TB-7 for a zero output. Check "FUND."

2. In "FUND," 1V range, apply 1V A. C. to input and adjust R711 on TB-7 for 10V D. C. output. In "QUAD" adjust C705 on TB-7 for zero output. Check "FUND."

3. In "FUND," 10V range, apply 10V A. C. to input and adjust R705 on TB-7 for 10V D. C. output. In "QUAD," adjust C701 on TB-7 for zero utput. Check "FUND."

4. In "FUND," 100V range, apply 100V A. C. to input and check for 10V, D. C. output. In "QUAD" check for zero output.

5. In "FUND," 1,000V range, apply 300V A. C. to input and check for 3V D. C. output. In "QUAD" check for zero output.

E) Range Quadrature Trim (Transformer, "QUAD" Mode). All adjustments made to ± 2.0mv, applicable to units with optional signal input transformer only.

PSC-410

1. In 1V range position, apply 1V in-phase input and adjust C101 on TB-1 for zero output.

2. In 10V range position, apply 10V in-phase input and adjust C102 on TB-1 for zero output.

PSC-410

3. In 100V range position, apply 100V in-phase input and adjust C103 on TB-1 for zero output.

4. In 1,000V range position, apply 300V in-phase input and adjust C104 on TB-1 for zero output.

5. Check linearity as in II-B-4 (should be within 10mv).

PSC-411

1. In 10mv range position, apply 10mv in-phase input and adjust C101 on TB-1 for zero output.

2. In 100mv range position, apply 100mv in-phase input and adjust C102 on TB-1 for zero output.

3. In 1V range position, apply 1V in-phase input and adjust C102 on TB-1 for zero output

4. In 10V range position, apply 10V in-phase input and adjust C1901 for zero output.

5. In 100V range position, apply 100V in-phase input and check for zero output.

6. In 1,000V range position, apply 300V in-phase input and check for zero output.

7. Check linearity as in II-B-4, (Should be within 10mv).

CAUTION

High voltage exist at several points in the instrument. Normal precautions consistent with good practice should be taken to reduce shock hazard.

A potential shock hazard exists when ungrounded power source or ungrounded case operation is employed. Persons operating the instrument should be made aware of and take precautions against this condition.

North Atlantic Industries, Inc. cannot be held responsible for damage to person or property in the process of or as a result of maintenance, calibration or setting up of instrument.

WARRANTY

North Atlantic Industries, Inc. hereby warrants that this instrument is free from defects in material and workmanship. Liability under this warranty is limited to servicing, calibrating, and replacing any defective parts with the exception of electron tubes and fuses, if within one (1) year after shipment the original purchaser notifies North Atlantic Industries, Inc. that the instrument is defective. Notification to the Sales Order Department of North Atlantic Industries, Inc. should give full details of the defect, including model and serial number of the instrument. Purchaser shall then await servicing or shipping instructions from North Atlantic Industries, Inc.

North Atlantic Industries, Inc. will repair and pay transportation charges of any instrument that is found defective during the period of our warranty. This shall be subject to the condition that there is no evidence that the instrument has been operated beyond its design range, has been improperly tested, or has been opened, disassembled, modified, dropped or tampered with in any way.

In the event that repairs are necessary which are not covered by the warranty, an estimate of costs to be incurred will be submitted for written approval before any work other than determining the defect is undertaken.

In-warranty repairs will be returned, transportation paid, by the original methods of shipment. Repairs not covered by the warranty will be returned in accordance with purchaser's instructions submitted with approval of repair charges.

North Atlantic Industries, Inc. shall not be liable for damage or injury to persons or property resulting from the operation of the instrument.

NOTE

This instrument has been carefully checked and packaged prior to shipment. Any loss, damage, or delay in shipment should be reported to the carrier. Further, if upon receipt the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier claim agent and forwarded to North Atlantic Industries, Inc., who will advise disposition and arrange for repair or replacement of the instrument.

In line with North Atlantic Industries' policy of prompt service to all customers, every effort will be made to repair and return any instrument as rapidly as possible.

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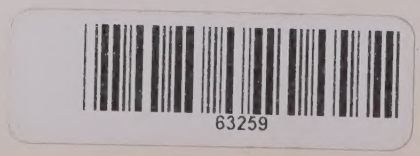
63259